Simulating Surface Plasmons at Metal Surfaces and Its Application in Optoelectronic Devices

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Abstract

Surface plasmon polaritons (SPP) are guided electromagnetic modes of a metal/dielectric interface. These surface electromagnetic waves arise through the coupling of the incident electromagnetic radiation with the collective charge-density oscillations of the free electrons in a metal. Because of its strong field confinement and enhancement effect, SPP has found a variety of intriguing applications in, e.g., surface-enhanced spectroscopy, biosensing, and nano-optics.

Due to mismatch in the propagation wave vectors, an incident plane wave in the dielectric cannot directly excite the SPP wave at a smooth metal/dielectric interface. Rather, the SPP can be launched through several special excitation configurations or coupling structures. In this presentation I will share with you the simulation of SPP excitation in COMSOL Multiphysics Wave Optics module, covering the Kretschmann-Raether configuration, the Otto configuration, grating coupling, and scattering at nano-scale discontinuities/defects. Interesting SPP phenomena such as the short range and long range coupled SPP at optically thin metal films, and a SPP focusing lens will be illustrated. And at the end, the SPP effect in two optoelectronic devices, the organic light emitting diode (OLED) and the surface plasmon-enhanced fluorescence spectroscopy (SPFS), will be exampled.

Figures used in the abstract

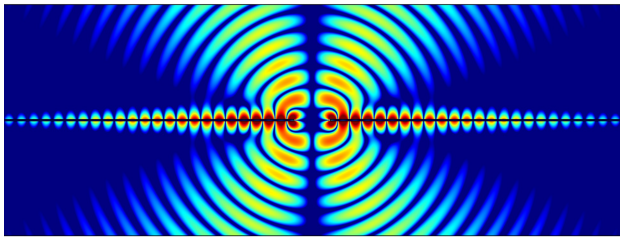

Figure 1: Simulated field distribution of light scattering at a wavelength-scale slit through an optically thin metal film, showing the excitation of the coupled surface plasmon polaritons (the short range SPP) at the metal surfaces.